

Verification of Impervious Coverage Data from the National Land Cover Database for the Little Blue River Watershed in Jackson and Cass Counties, Missouri

By Brooke N. Brewington and Eric D. Christensen
 U.S. Geological Survey, Lee's Summit, Missouri, bbrewington@usgs.gov, echriste@usgs.gov

Introduction

The U.S. Geological Survey (USGS), in cooperation with the City of Independence Water Pollution Control Department, evaluated land use effects on contaminant transport within the city as part of a multi-tiered study. The National Land Cover Database (NLCD), available at <http://www.mrlc.gov/nlcd2011.php>, often is used for hydrologic modeling because of its broad coverage and availability. However, accuracy limitations of the NLCD data have the potential to substantially affect modeling results. Impervious surfaces can be inaccurately estimated by the Landsat-based imagery that is used to develop the NLCD data.

To evaluate the accuracy of the NLCD impervious surface data for the Little Blue River Watershed (fig. 1), land use categories from 2011 NLCD data were used to create randomly selected 30-meter grid cells. The NLCD impervious coverage (fig. 2) was assessed through visual and digital estimation of impermeable surfaces in the Little Blue River Watershed in Jackson and Cass counties, Missouri. Using digitally estimated areas for verification allowed for a better understanding of both the visually estimated and the NLCD-determined values.

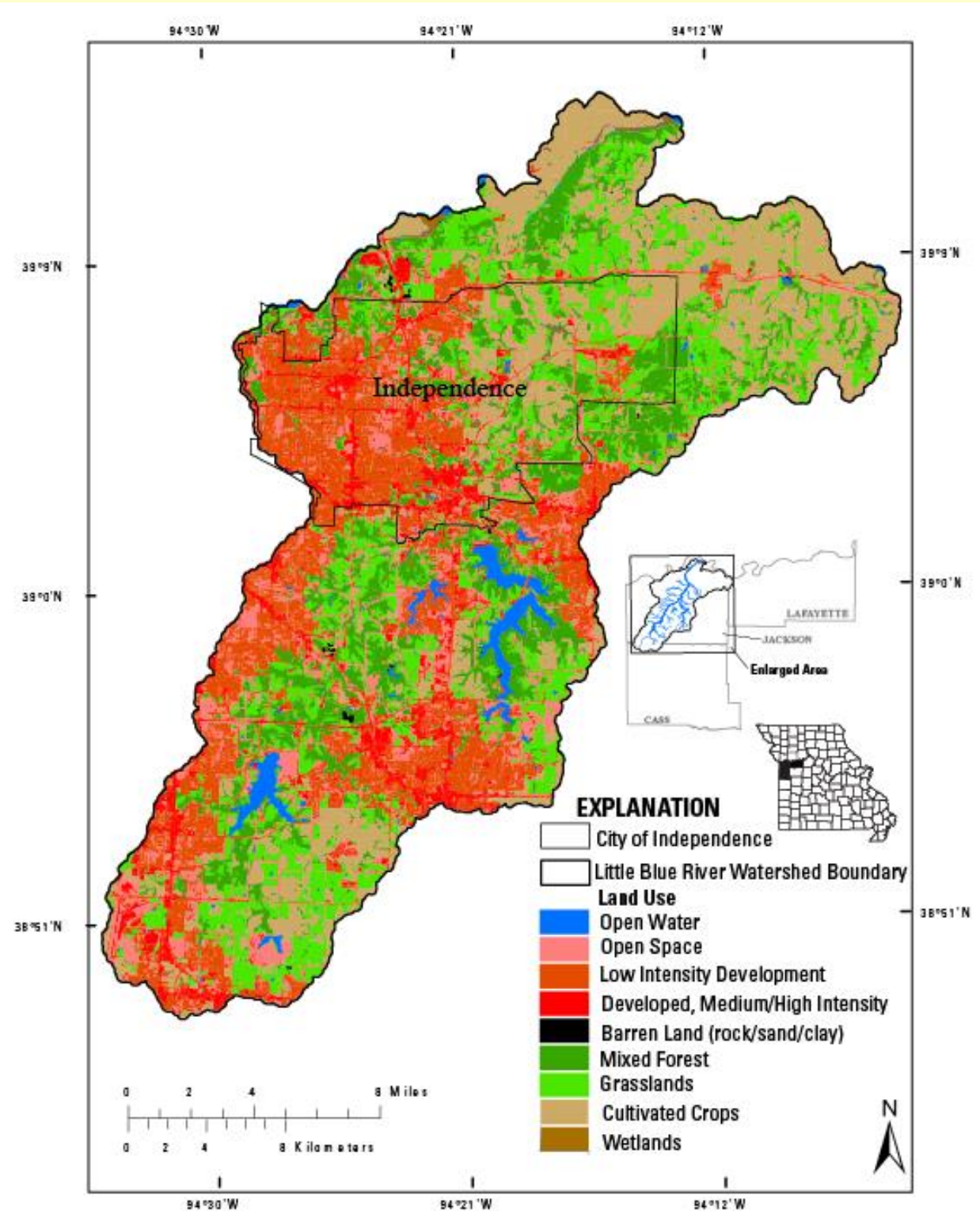


Figure 1. NLCD 2011 land use coverage within the Little Blue River Watershed.

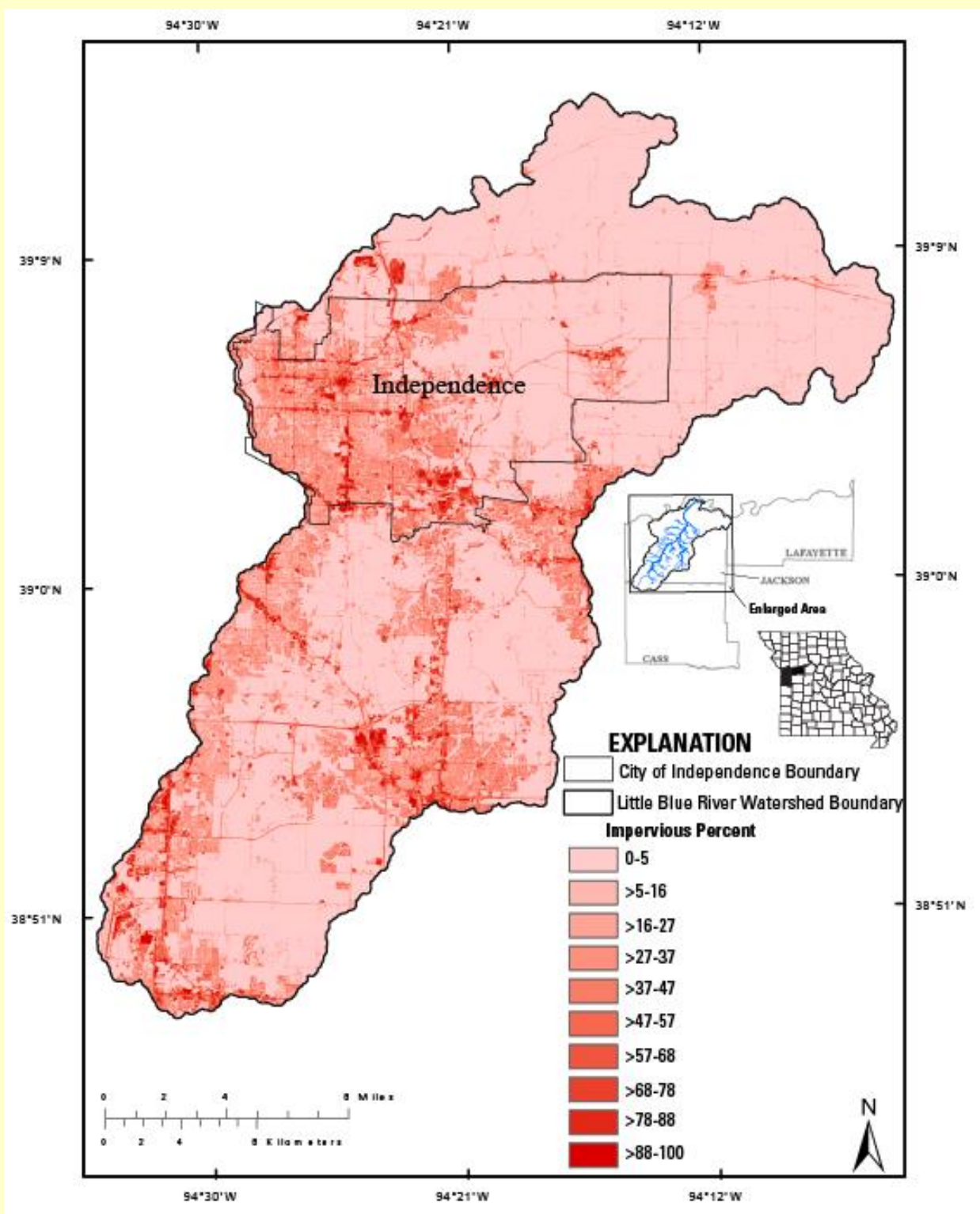


Figure 2. NLCD 2011 impervious coverage within the Little Blue River Watershed.

Procedure

For the 823-square kilometer Little Blue River Watershed, random points were generated in ArcGIS® for each specified land use category (table 1) with a target of 100 points per category. A 100-meter point-separation requirement was specified resulting in the barren-land category having only 21 random points, so a total of 821 random points were mapped (fig. 3). A 30-meter grid feature was overlaid on the NLCD polygon coverage to act as a guide. The grid cell that the random point fell within was then selected for comparison (fig. 4). Land-use values for the selected grid cells were added to the random point attribute tables (table 2). The percent impervious surface for each random grid cell was then estimated visually. This was accomplished by overlaying the 2011 NLCD land use coverage at high transparency over the 2007, 1:24,000 scale, USGS Digital Orthophoto Quarter-Quadrangle developed using leaf-off imagery (fig. 5). The impervious percentage was visually estimated in increments of 5 and entered into the attribute table for the randomly selected grid cells (table 3).

Count of Random Points		
Category	Land Use Code	Total
Open Water	11	100
Open Space	21	100
Low Intensity Development	22	100
Medium/High Intensity Development	23	79
	24	21
Barren Land	31	21
Mixed Forest	41	99
	42	1
Grasslands	52	2
	71	18
	81	80
Cultivated Crops	82	100
Wetlands	90	89
	95	11
Total selected points		821

Table 1. Land use categories.

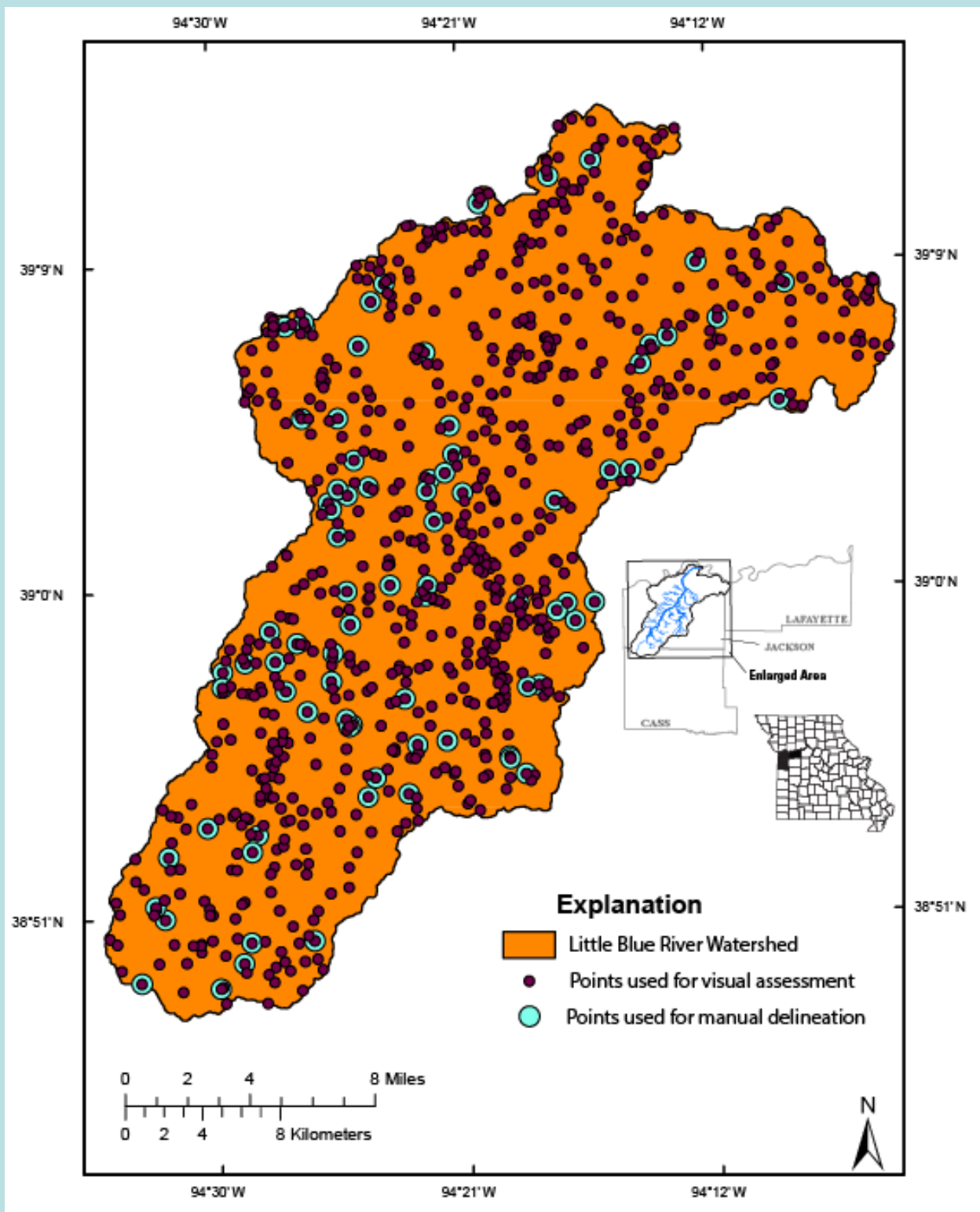


Figure 3. Random points generated for the pixel selection process and subset of points generated for confirmation of estimated impervious area.

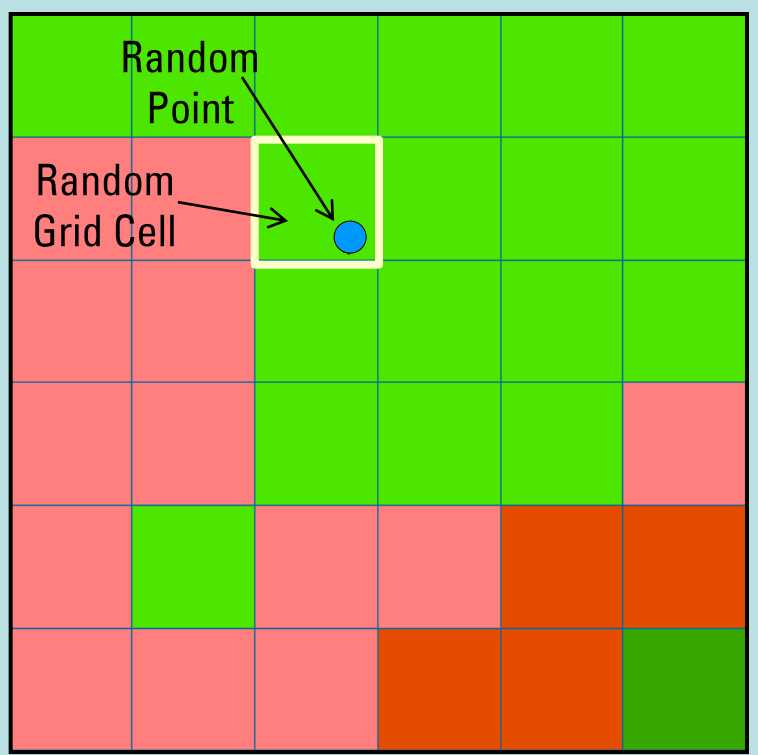


Figure 4. Grid network and a random point generated for grasslands land use category with the associated grid cell selected.

FID	Shape	Land_Use_Code
280	Point	61
281	Point	71
282	Point	71
283	Point	71
284	Point	81
285	Point	81

Table 2. Random point attribute table with land use grid codes.

FID	Shape	Land_Use_Code	Percent_Impervious
430	Point	23	95
431	Point	23	80
432	Point	23	70
433	Point	23	75
434	Point	23	60
435	Point	23	85
436	Point	23	40

Table 3. Random point attribute table with visual assessment of percent impervious cover.

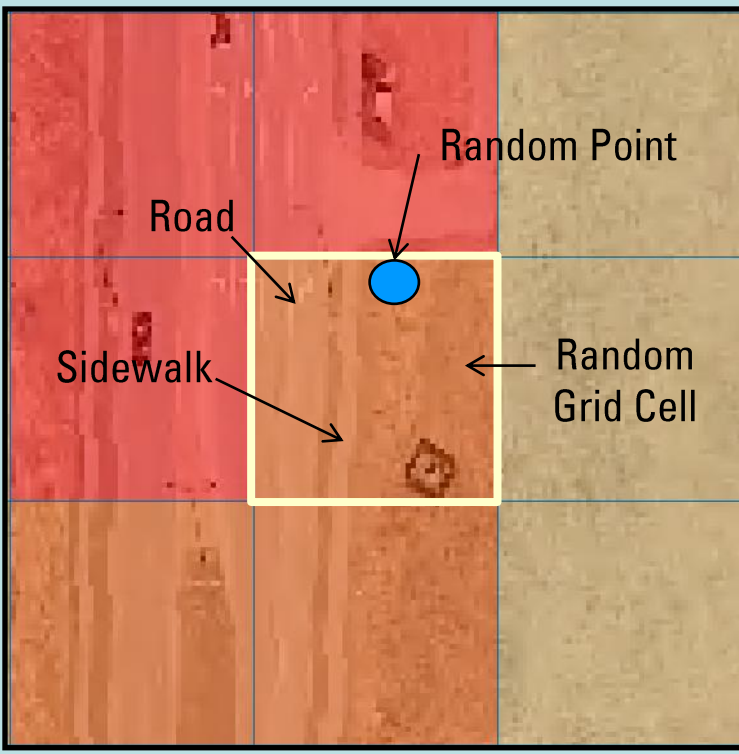


Figure 5. Land use category: low intensity development visual estimate: 45% impervious.

A subset of 10 percent of the visually estimated grid cells were randomly selected to undergo digital estimation of impervious area (fig. 3). Polygon features were digitized over the impervious surfaces for each of the grid cells as determined from the leaf-off imagery and then the polygon area was calculated to get a percentage of impervious surface area (fig. 6). The percent difference between the visual and digital estimation methods was then compared (fig. 7). The digital estimation subset was then compared to the NLCD impervious coverage data (fig. 8) and the percent difference between the two was calculated. The NLCD impervious data were then compared to the visually-estimated grid cells (fig. 9).

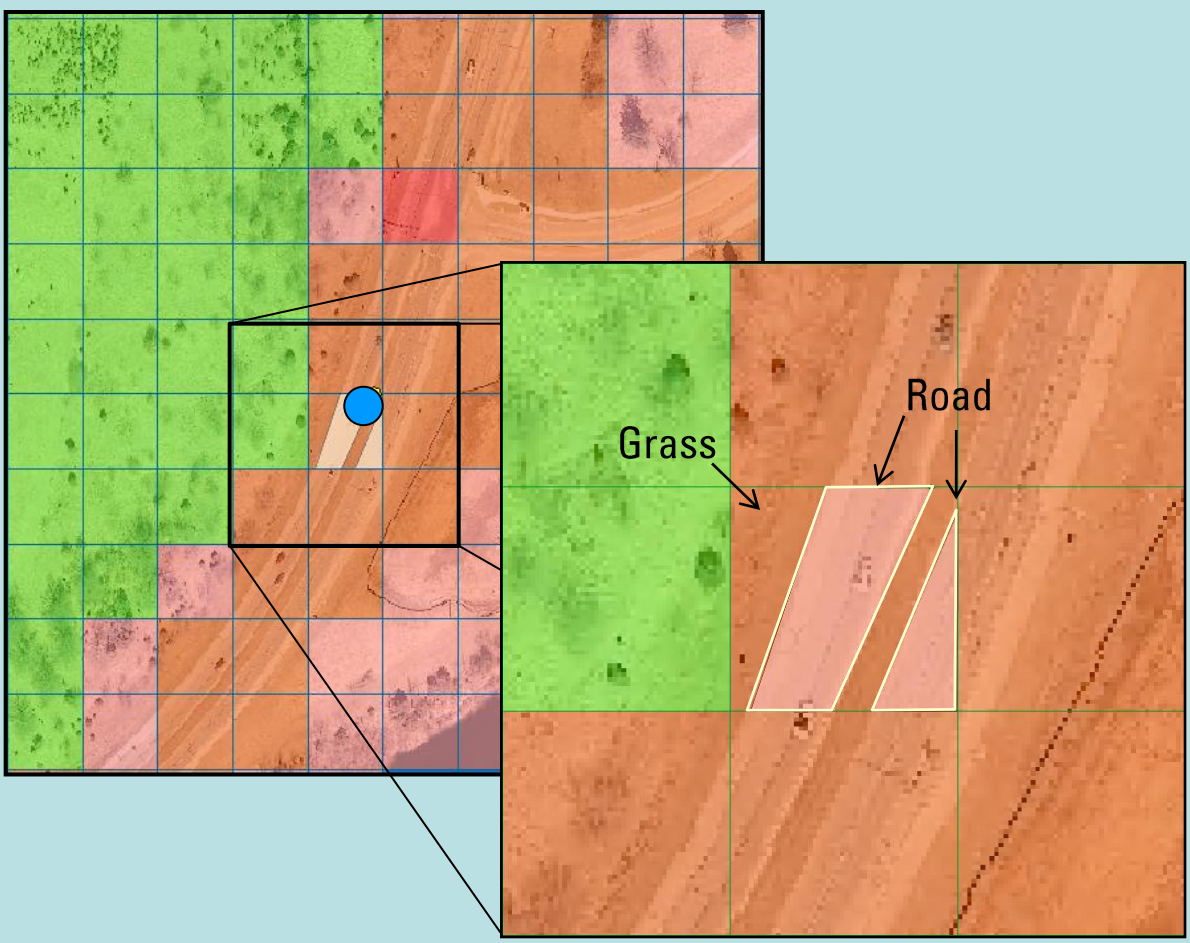


Figure 6. Land use category: low intensity development, impervious area visual estimate percent: 45%, digital estimate percent: 58.2% difference: 13.2%.

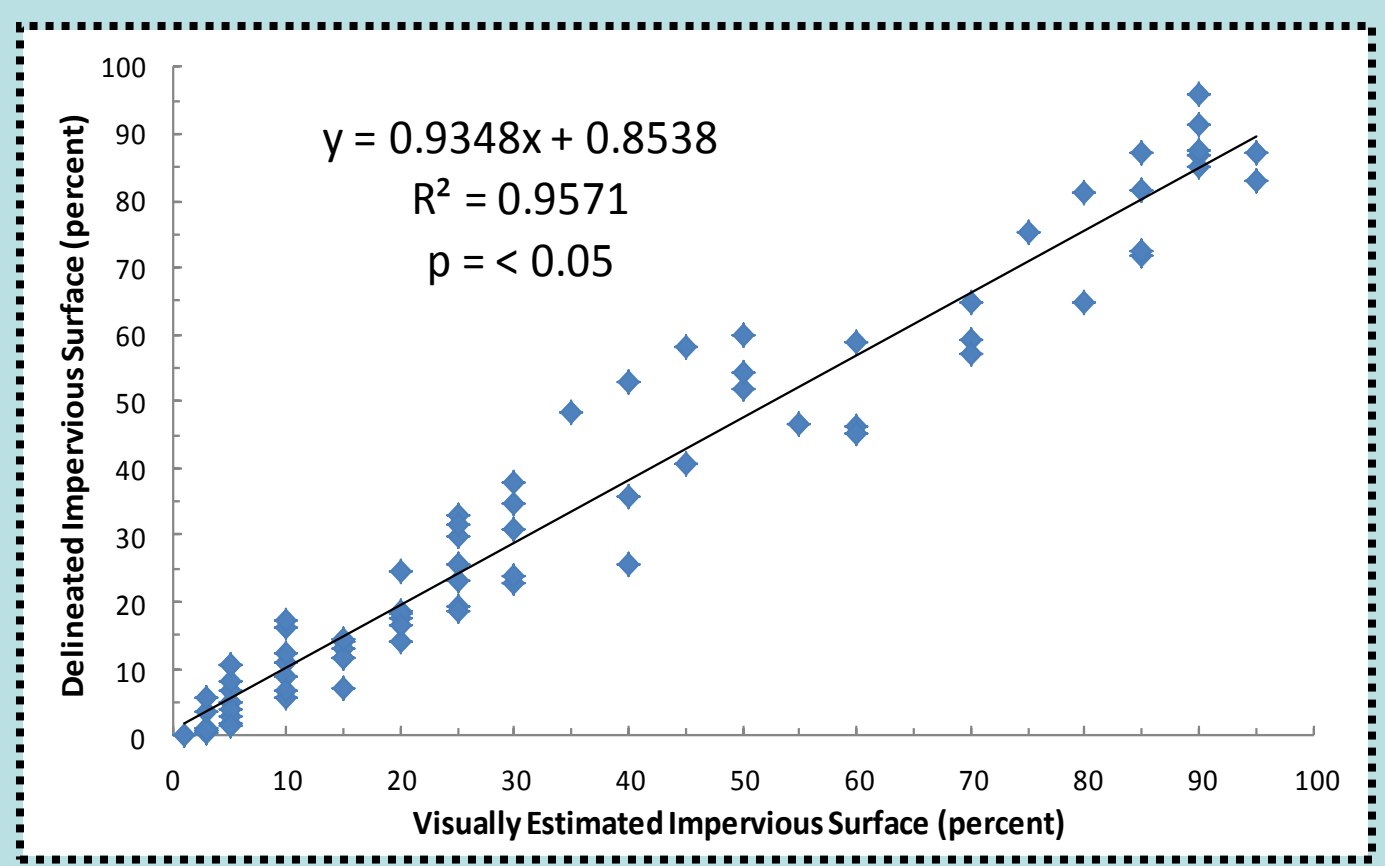


Figure 7. Comparison of visually and digitally estimated impervious surfaces.

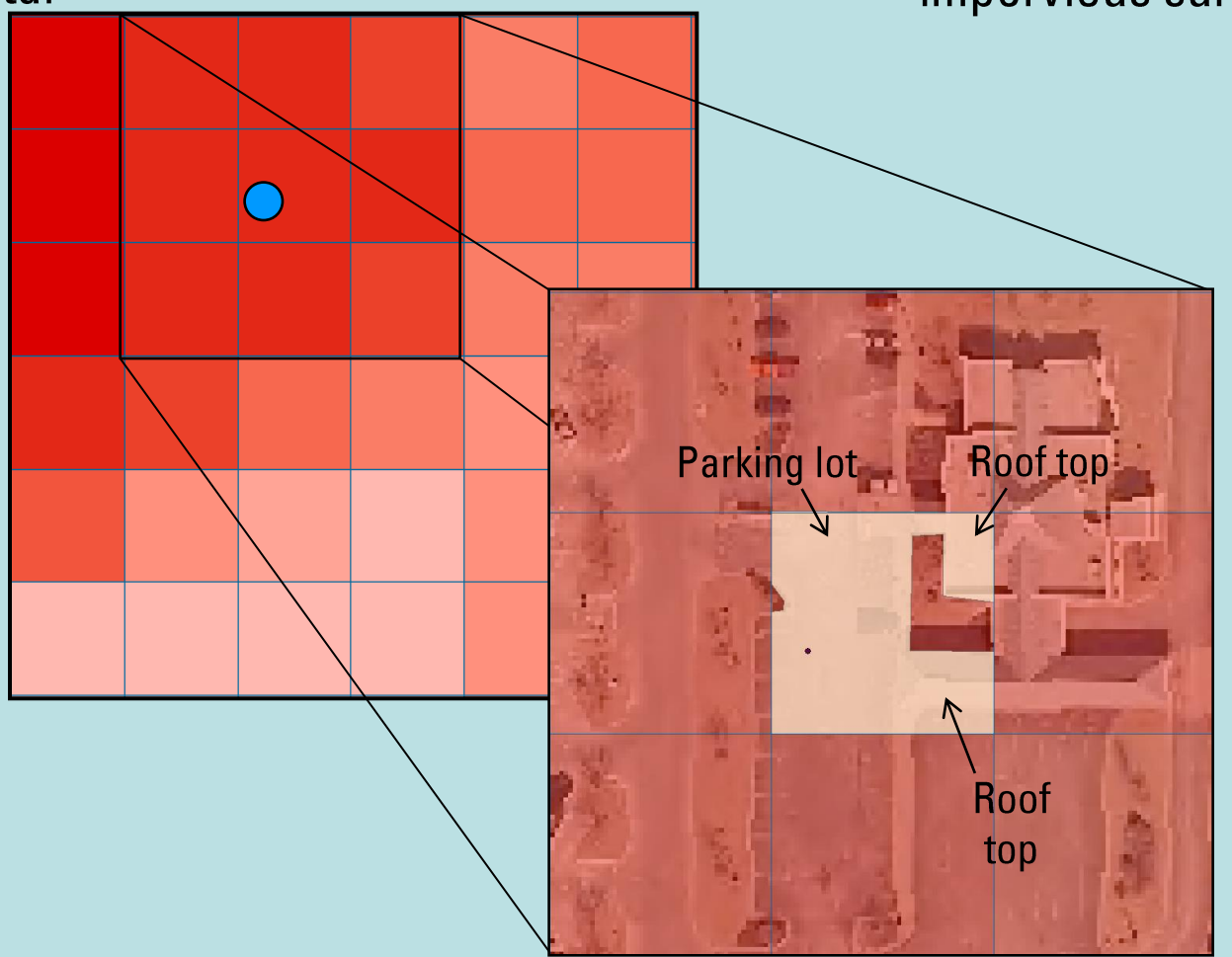


Figure 8. NLCD percent impervious: 88% digital estimate percent: 87.2% difference: 0.80%.

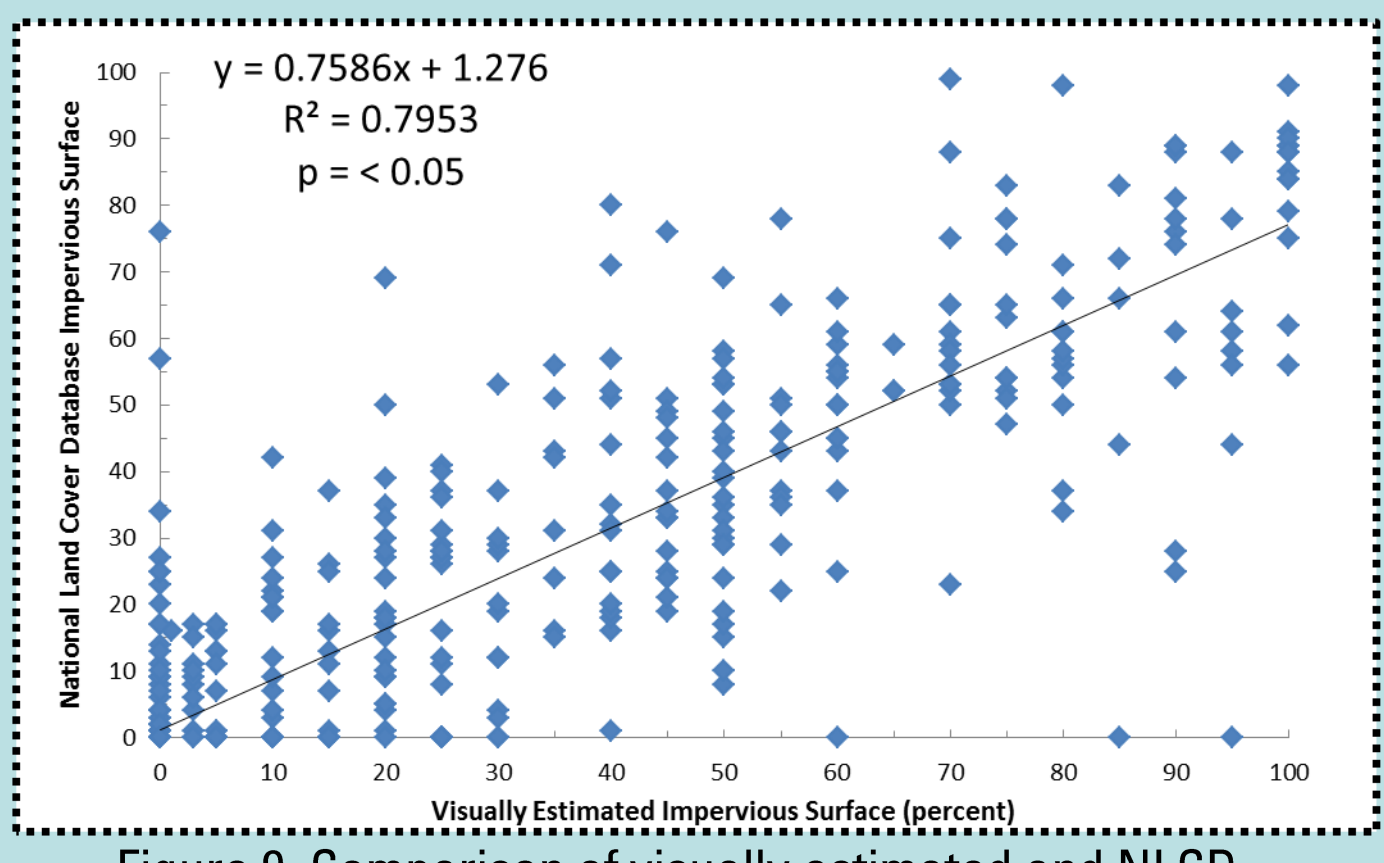


Figure 9. Comparison of visually estimated and NLCD impervious percentages.



Discussion

The average difference for NLCD impervious area values compared to visually and digitally estimated values were both about 16 percent. Compared to the digitally estimated values, the visually estimated cells showed a 3 percent average difference for undeveloped areas and 6 percent average difference for developed areas. When compared to the visually estimated values, the NLCD values on average underestimated impervious surface area for developed land uses by about 7 percent and undeveloped land uses by about 17 percent. The visual estimation values were more accurate for undeveloped land-use areas primarily because the NLCD land use data assumed 0 percent impervious surfaces in these areas. The individual grid cell differences determined for all land uses between visually estimated and NLCD impervious area ranged from about -40 to 85 percent. Previous studies have assessed impervious surfaces by grouping land cover categories similar to the procedure used in this study. These studies found that the computed NLCD values underestimated impervious surfaces primarily in undeveloped areas (Claggett and others, 2013; Nowak and others, 2010; Wickham and others, 2012). The addition of verification for both the visually estimated and NLCD data values through digital estimation of impervious area confirms the visual assessment method.

Conclusion

Digitally estimating the impervious areas confirmed the accuracy of the visually estimated values. The visually estimated values were more accurate than the NLCD data for undeveloped categories whereas the NLCD values were marginally more accurate than the visually estimated values for developed areas as determined using digital estimation of impermeable areas for verification. Our results show that when evaluating areas with substantial undeveloped land use it is important to carry out accuracy assessments of the NLCD data to ensure the integrity of the dataset. With these findings, the visual assessment method will be used to modify NLCD impervious values to develop a hydrologic model for the study area to predict runoff by land use class.

References

- Claggett, P.R., Frederick M.I., and Thompson, R.L., 2013, Estimating the extent of impervious surfaces and turf grass across large regions.: Journal of the American Water Resources Association, vol.49, no.5, p.1057-1077.
- Nowak, D.J., and Greenfield, E.J., Evaluating the National Land Cover Database tree canopy and impervious cover estimates across the conterminous United States: a comparison with photo interpreted estimates: Environmental Management, vol.46 no.3, p. 378-390.
- Wickham, J.D., Stephen V. Stehman, Leila Gass, Jon Dewitz, Joyce A. Fry, and Timothy G. Wade, 2012, Accuracy assessment of NLCD 2006 land cover and impervious surface: Remote Sensing of Environment, vol.130, p. 294-304.